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# The Case of Phosphate Fertilizer

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# The Case of PHOSPHATE FERTILIZER



**Response of Crops  
Varies With Their  
Kind and With Soil  
Type on Which the  
Application Is Made**

**M**ANY AN IOWA farmer is aware that some day he may need to use commercial fertilizer, especially phosphate, in order to produce crops satisfactorily. He wonders, "Has that time arrived? Could I profitably increase my crop yields by applying fertilizer?"

How nice it would be if we could say to every Iowa farmer, "Yes, it undoubtedly will pay you to apply phosphate," or "No, you don't need to use phosphate fertilizer. It won't pay."

But it isn't that easy. We have sufficient information so that we may say to some farmers, "You are likely to get a good increase in yield by the use of superphosphate;" — to others, we must say, "Our tests have not shown enough increase to indicate that superphosphate ap-

plications would pay."

Results of our experiments indicate that the use of a phosphate fertilizer generally increases crop growth on some soil types, especially with certain crops, and gives no increase on some other soils. The amount of response that may be obtained on any of our soils, however, is governed to a large extent by past management. A soil to which considerable manure has been added and on which numerous clover crops have grown will not need phosphate as much as will one not so well handled.

The Iowa Station for more than a quarter of a century (since 1915) has had cooperative field test plots scattered about Iowa on most of the important

soil types and in almost all parts of the state. These test plots were in farmers' fields and were farmed and handled just as were the other fields on those farms.

Certain of these plots were treated with 120 pounds of 20 percent superphosphate applied to each corn crop and each oat crop but not to the hay crop. Thus in a 4-year rotation that consisted of corn, corn, oats and clover, each acre would receive 360 pounds of superphosphate (240 pounds with the two corn crops and 120 pounds with the oats) during the 4-year period.

Since superphosphate must be well mixed with the soil in order to be of use to the crop, it was not possible to add phosphate while the land was in clover. Much of the benefit for the use of superphosphate when clover

**By A. J. ENGLEHORN**





Tomatoes showed the greatest response to phosphate fertilization of any of the plants in the greenhouse tests. In general, truck crops increased more than field crops.

is seeded is due to better stands insured by this material. Yields of clover hay are therefore greater when this fertilizer is used, not only because of more vigorous plant growth, but also because of more plants.

To check the value of superphosphate, plots alongside those getting phosphate fertilizer were left unfertilized.

We took the results obtained on all these fields and averaged them according to soil types. Superphosphate usually brought substantial increases in yields for all crops. But the response between corn, oats and mixed hay differed, and these crops did not respond similarly on all soil types. The table, bottom of page 6 shows the results obtained.

In most instances, corn responded less than oats or mixed hay to superphosphate. Oats showed more response than corn to phosphate on all but one soil, but the percentage step-up in mixed clover-timothy hay yield was generally still larger than that of oats. The largest corn increase was about  $7\frac{1}{2}$  bushels

per acre. On several soil types it was  $\frac{1}{2}$  bushel to 1 or 2 bushels an acre. If corn is worth 60 cents a bushel, and it costs \$1.80 (figuring superphosphate at \$30 a ton or  $1\frac{1}{2}$  cents a pound) for the fertilizer, a farmer with a soil type on which probably no more than a 1- or 2-bushel increase may be obtained should consider carefully whether or not to apply phosphate on corn.

Oats stood in second place in response to superphosphate on 12 of the 16 soil types. They outranked both corn and clover on Grundy silt loam, but were below both these crops on Shelby loam, Webster silty clay loam and Waukesha silt loam. On only one soil, was there no increase in oat yields for the use of phosphate fertilizer—on Waukesha silt loam. Superphosphate stepped up the yield from 2 to 4 bushels per acre on many of these soils, increased it 6, 7 and 9 on several others and boosted it more than  $14\frac{1}{2}$  bushels on one soil type.

If oats are figured at 30 cents a bushel, the average increase in

value of the yield for adding superphosphate ranged from a little better than 50 cents an acre to \$4.41 an acre. Thus if 120 pounds of superphosphate had been added at a cost of  $1\frac{1}{2}$  cents per pound, or \$1.80 an acre, in some instances it would have been a very profitable investment, in others not.

The story with the mixed clover-timothy hay is different: In every case the plots which had received superphosphate with the oats at the time the hay crop was seeded showed an increase in the amount of hay. These increases, with the hay valued at \$8 a ton ranged from \$1.36 to almost \$7 an acre. If the increase in value of the oat crop is added to the hay crop which followed, then the argument for adding phosphate at the time of seeding the oats and clover becomes much stronger; on every one of these 16 soil types, a farmer would have lost nothing, on the average, to have added phosphate if he could do it at a cost of \$1.80 an acre, and he might have increased the value

of the oats and hay crops nearly \$11.50 an acre. The lowest increased return from the hay crop alone for the addition of phosphate was \$1.36 an acre—not far from the cost of the fertilizer.

### Greenhouse Results

We have known for a long time that plants differed in their response to phosphorus. To find out more about their difference in response, we carried on tests over a 2-year period in the greenhouse at Iowa State College with eight different kinds of plants. These included grain, hay and truck crops.

According to these tests, it is evident that all plants do not respond equally well to superphosphate even when it is added to soils deficient in phosphorus. When superphosphate was added in liberal amounts to a deficient soil, certain plants made substantially increased growth, while other plants under identical conditions and on the same soil grew about as well without as with the superphosphate.

Apparently some plants are able to get along with small amounts of this plant food. Plants, it seems, differ both in the amount of phosphorus they require and also in their ability to get phosphorus out of the soil. In other words, phosphorus is more available to one type of plant than to another.

For our greenhouse tests we used a Clarion loam that, according to chemical tests, was low in available phosphorus. This soil was placed in pots, and 20 percent superphosphate was added at a rate of 400 pounds per acre. Half the pots got phosphorus and the other half were left as checks—unfertilized. Nitrogen and potash were added to be certain that the plants would not suffer because of a lack of these elements. In other words, we wanted to make sure that any difference in growth was due to the addition of superphosphate to this phosphate-deficient soil.

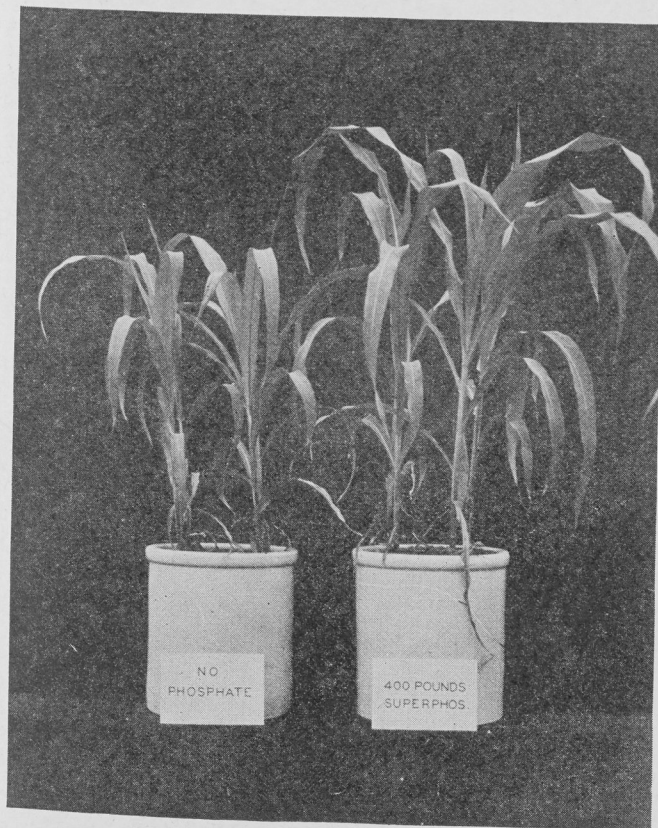
Several plants which would be representative of different groups of farm and truck crops were selected for growth in

these pots. All of the plants increased in yield when superphosphate was added. The amount of response is shown in the accompanying table. These tests show that plants may be placed in three classes with respect to their response to superphosphate: 1. Those that respond very well; 2. those that respond to a medium degree; 3. those that respond only slightly.

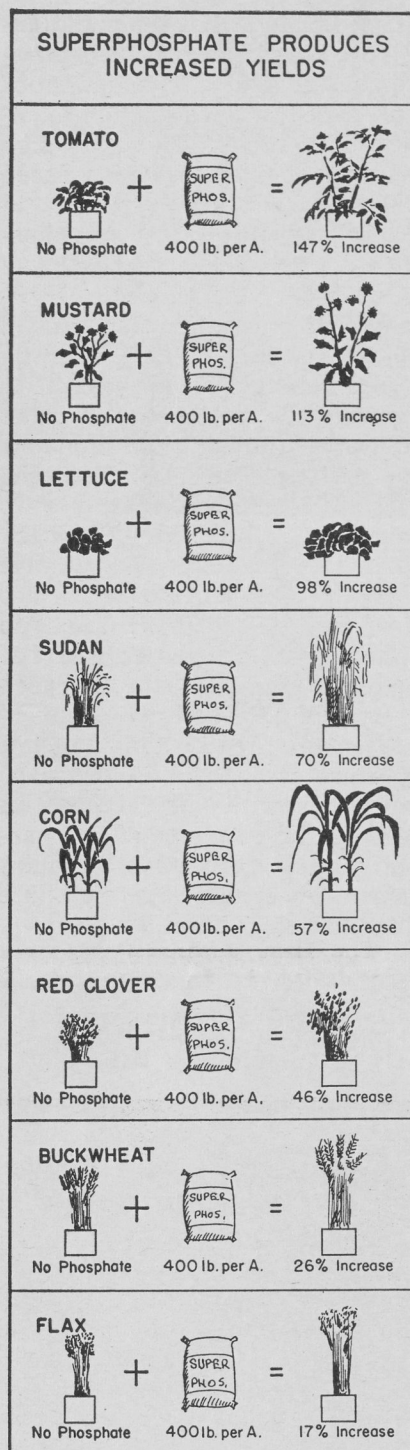
In general, it appears that some of the truck crops are most responsive to additions of superphosphate. For instance, the tomato plants consistently gave high returns, the fertilized plants averaging 147 percent more in growth than those not fertilized. Second in response was mustard, a member of the cabbage family. Its increased growth for the addition of superphosphate was 113 percent. Lettuce was third in order of response with an increase in growth of 98 percent. Apparently these three plants require much phosphate, and it must also be easily obtained.

Some of the farm crops were

**In the greenhouse tests, corn showed much greater response to phosphate fertilization than did flax. The increase for corn was 57 percent, but only 17 percent for flax.**







second in response. Leading the list was sudan grass with an increase of 70 percent, followed by corn with 57 percent and red clover, 46 percent. The position of corn and clover in response to phosphate was reversed in these experiments as compared with the field tests. In the field tests the increased yield of clover on the phosphate plots was probably the result in part of the increased stands. These

**RESPONSE OF SEVERAL CROPS TO THE ADDITION OF SUPERPHOSPHATE TO THE SOIL**

Crop	Percent increase for treatment
Tomato	147
Mustard	113
Lettuce	98
Sudan	70
Corn	57
Red clover	46
Buckwheat	26
Flax	17

three crops also require large amounts of phosphorus for satisfactory growth, but they do not respond to phosphate fertilizer to the extent that the truck crops do because they are good foragers.

Two grain crops—buckwheat and flax—were at the bottom of the list. They responded least to superphosphate additions. These two grain crops apparently get along with fairly small amounts of phosphorus. Some other grains probably would respond equally in similar circumstances.

The way the plants responded in the greenhouse may not necessarily mean that they will respond to the same extent out in the field. Plants in the greenhouse have optimum conditions, and results are not influenced by such factors as extreme variations in moisture, insect damage and the like. These greenhouse experiments, however, show that there is a difference in the needs of plants

for phosphorus and in their ability to gather this plant food from the soil. The results we obtained are, no doubt, indicative of the maximum that might be expected.

From the experiments conducted thus far in the field and in the greenhouse we have concluded:

1. Not all plants respond equally well to phosphate fertilization even though the soil may be deficient in this element.

2. The most profitable time to apply a phosphate fertilizer is when a small grain crop is planted, and a legume is seeded with it.

3. Good returns for the use of superphosphate may be expected on some of our soil types but probably not to the same extent on others.

4. If soils have been well managed, manure applied frequently and legumes grown in regular rotation, phosphate will not be needed to so great an extent as when management is not so good.

5. In order to be certain that a phosphate fertilizer application will be of benefit a farmer should make trial applications and should have his soil tested.

A discussion of the limitations and the possibilities of chemical tests for phosphorus needs will be discussed in a later issue.

**Increase in yield of corn, oats and clover-timothy hay on 16 soil types as a result of superphosphate fertilization\***

Soil type	Corn			Oats			Clover-timothy		
	Increase in fertilized plots over untreated			Increase in fertilized plots over untreated			Increase in fertilized plots over untreated		
	Bu.	%	Value	Bu.	%	Value	Ton	%	Value
Carrington loam	1.6	3	.96	7.6	14	2.28	.44	28	3.52
Carrington silt loam	2.0	4	1.20	7.4	13	2.22	.51	28	4.08
Clarion loam	.8	2	.48	3.4	6	1.02	.36	24	2.88
Clinton silt loam	1.1	3	.66	2.4	4	.72	.32	13	2.72
Grundy silt loam	4.0	6	2.40	9.3	18	2.79	.30	16	2.40
Grundy silty clay loam	1.1	2	.66	6.7	14	2.01	.57	25	4.56
Lamoure silty clay loam	.1	-	.06	14.7	25	4.41	.87	71	6.96
Marion silt loam	.5	1	.35	8.4	15	2.52	.53	40	4.24
Marshall silt loam	.5	1	.35	2.5	4	.75	.17	9	1.36
Muscantine silt loam	2.2	3	1.32	2.8	5	.84	.36	9	2.88
O'Neill loam	-	-	-	4.0	8	1.20	.43	28	3.44
Shelby loam	6.6	12	3.96	3.0	7	.90	.32	32	2.56
Tama silt loam	.8	1	.48	3.5	6	1.05	.26	14	2.08
Webster loam	3.3	6	1.98	4.6	9	1.38	.46	68	3.68
Webster silty clay loam	7.4	15	4.44	2.1	4	.63	.41	46	3.28
Waukesha silt loam	.9	2	.54	-	-	-	.23	13	1.84

\* These data represent average results obtained on a number of fields over a period of years. These fields were located on farms of better than average management, consequently it may be expected that greater returns may be obtained on similar soils of average management or less. In any case the return ratio as between the various crops should be about as shown here.